Stimulating Energy Innovation

Electrical Power Management

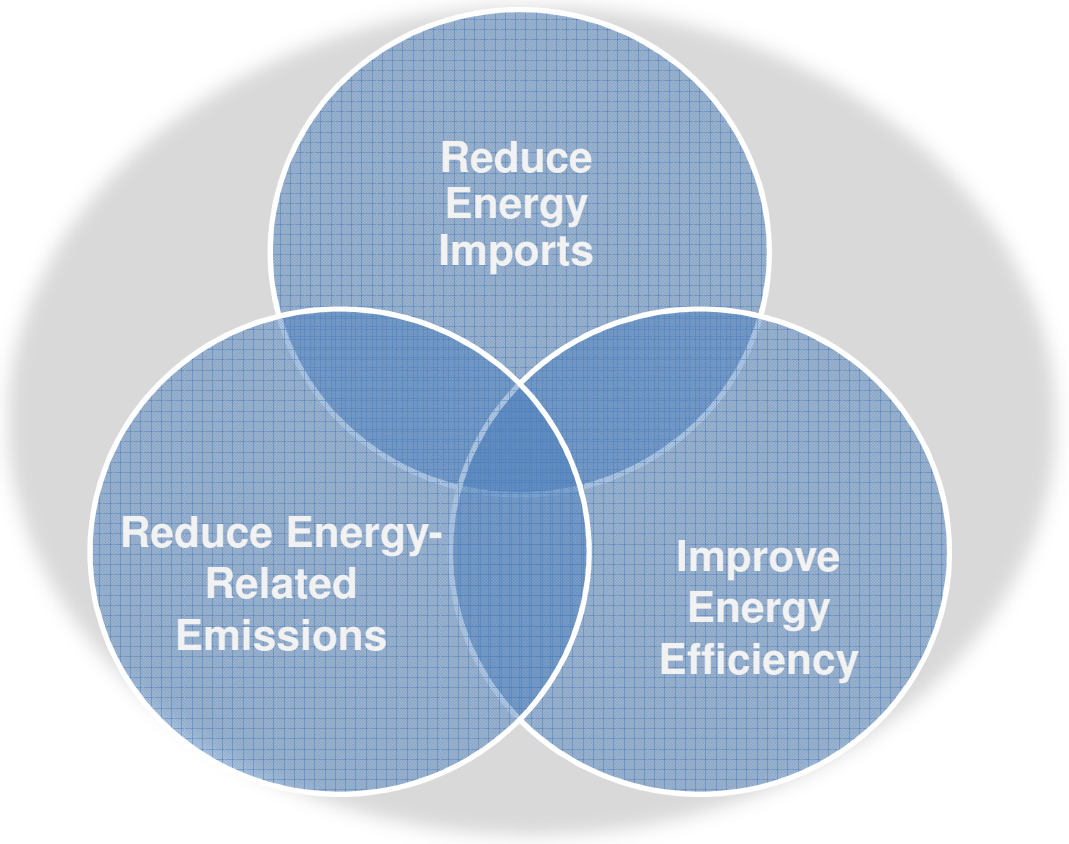
Rajeev Ram
Program Director
ARPA-E

Timothy Heidel
Fellow
ARPA-E

ARPA-E Mission

- To enhance the economic and energy security of the U.S.

- To ensure U.S. technological lead in developing and deploying advanced energy technologies



What makes an ARPA-E project?

1. Impact

- High impact on ARPA-E mission areas
- Credible path to market
- Large commercial application

2. Transform

- Challenges what is possible
- Disrupts existing learning curves
- Leaps beyond today's technologies

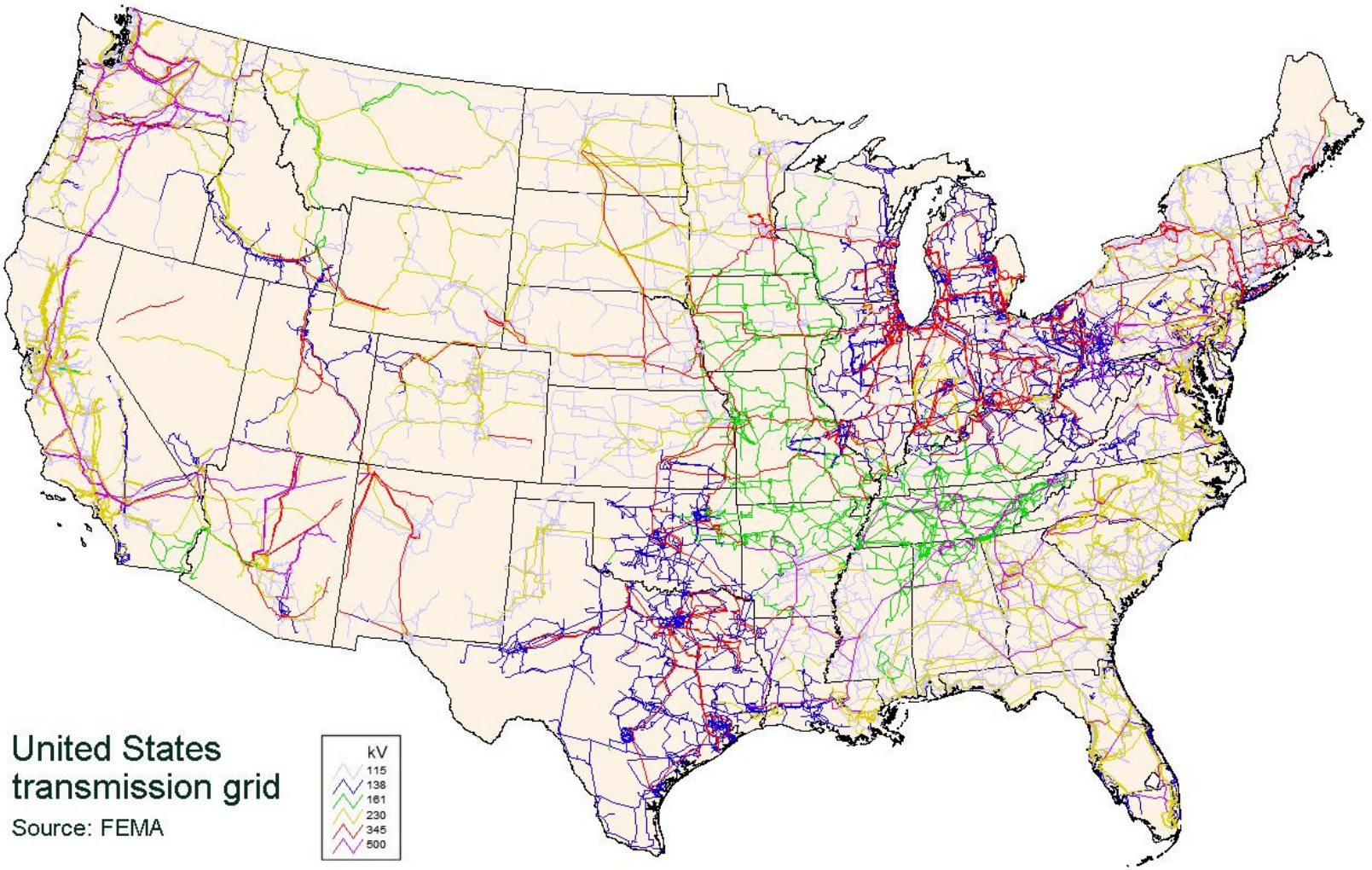
3. Bridge

- Translate science into breakthrough technology
- Not researched or funded elsewhere
- Catalyzes new interest and investment

4. Team

- Best-in-class people
- Cross-disciplinary skill sets
- Translation oriented

The U.S. grid

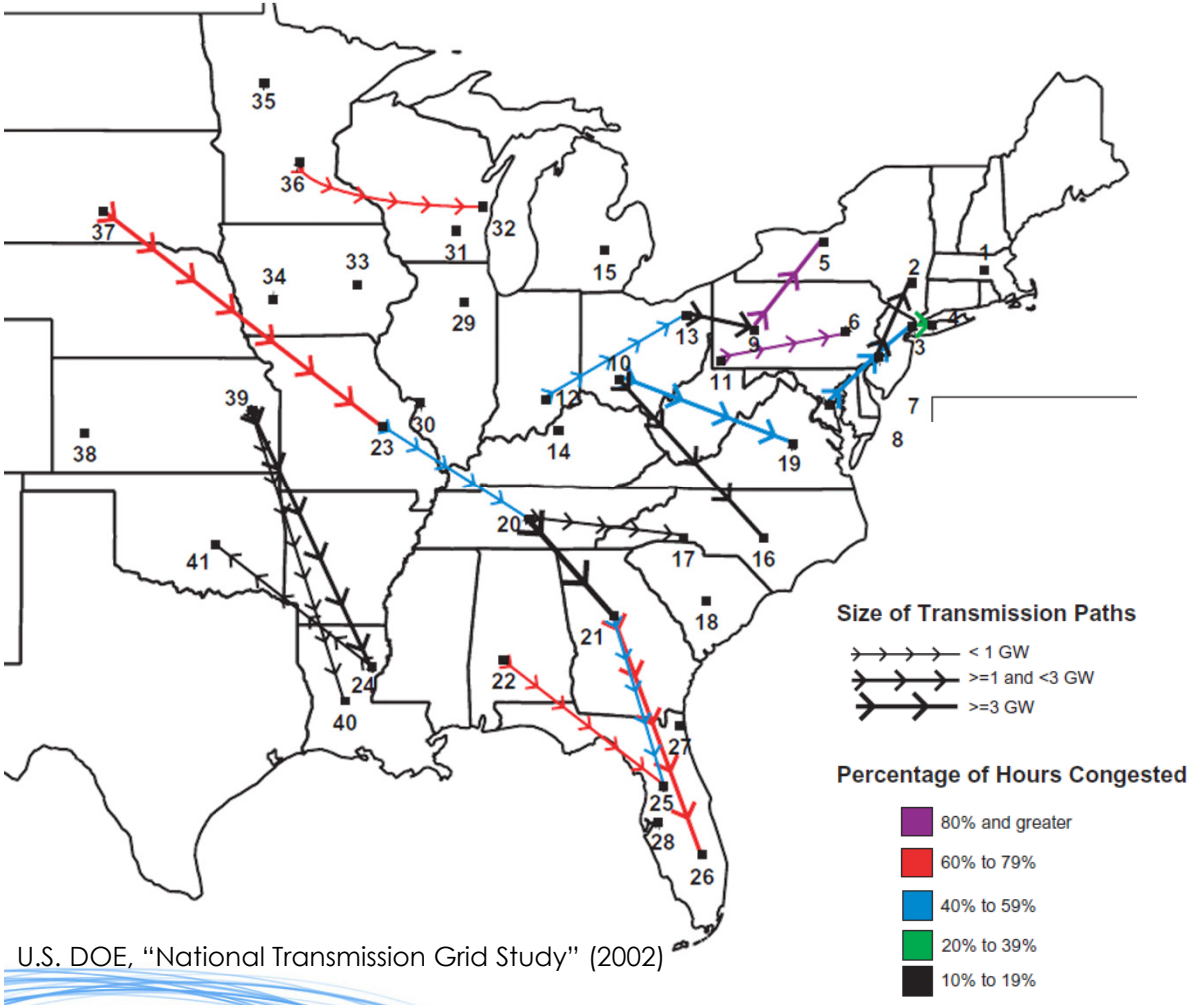


United States transmission grid

Source: FEMA

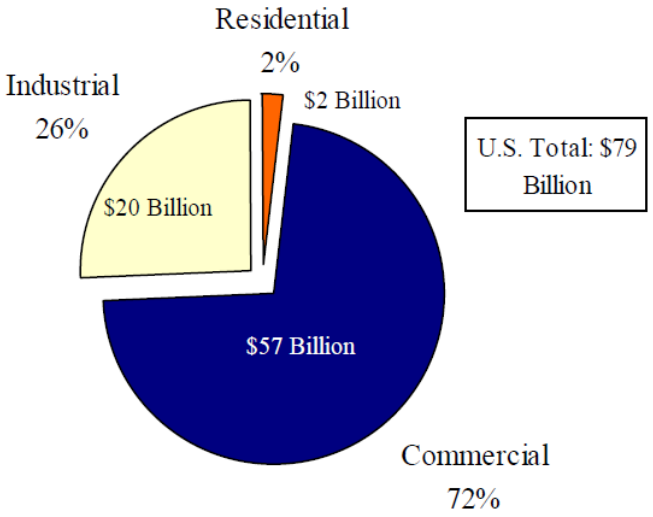
State of the U.S. grid

Congested Paths in the Eastern Interconnection



U.S. DOE, "National Transmission Grid Study" (2002)

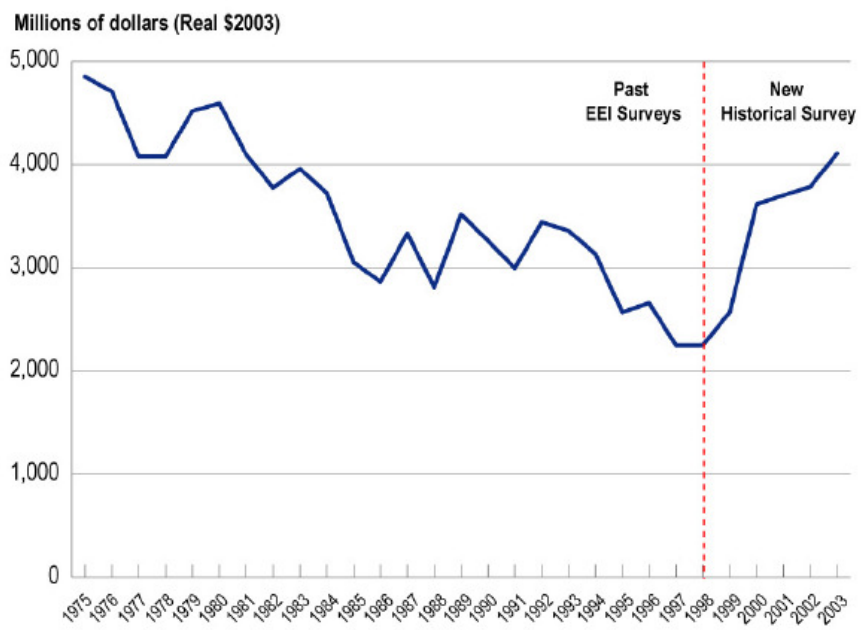
Annual Cost of Power Interruptions



Hamachi LaCommare and Eto, LBNL, "Understanding the Cost of Power Interruptions to U.S. Electricity Consumers," (2004)

Huge Opportunity for New Technology Adoption

Historical Transmission Investment

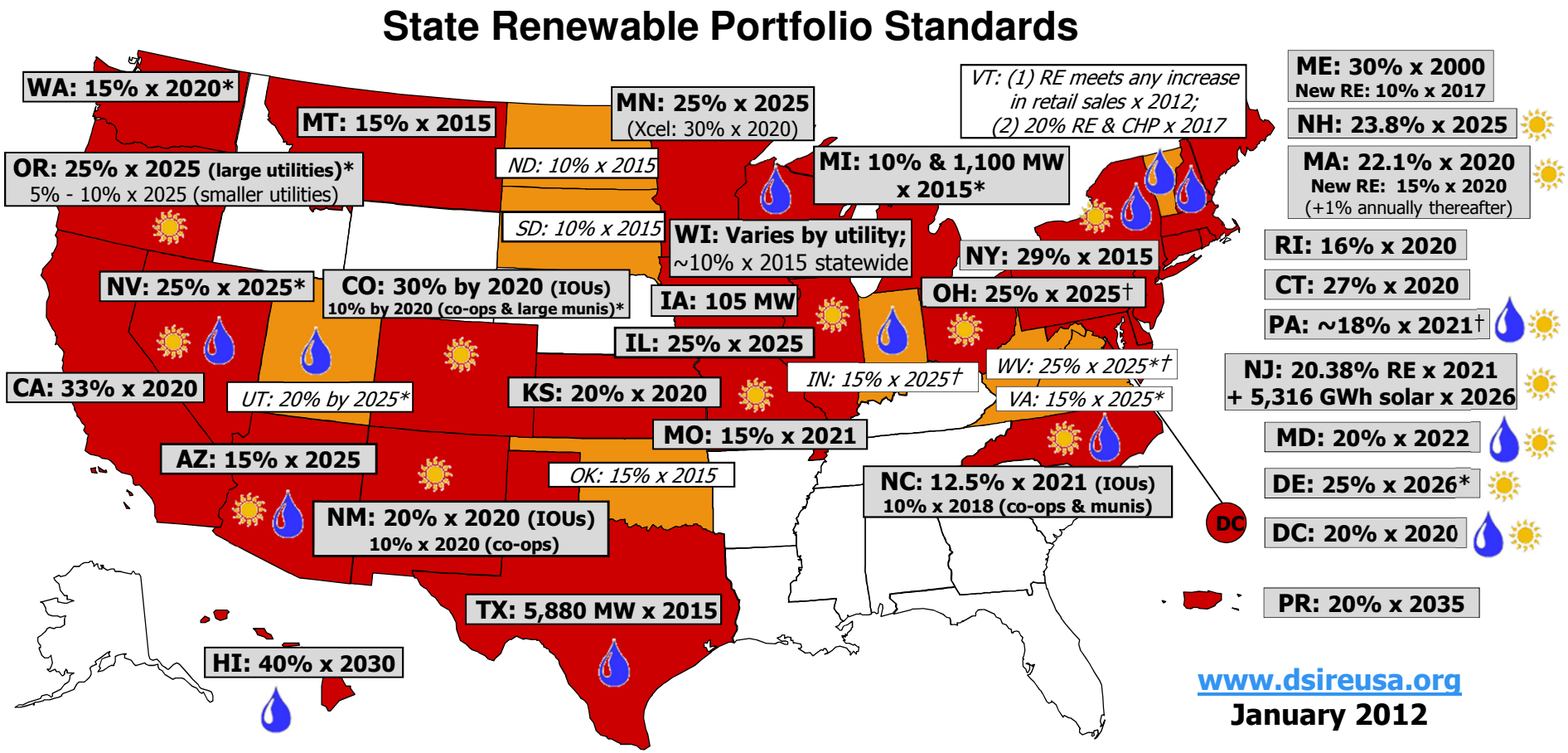


EEI Survey of Transmission Investment (2005)

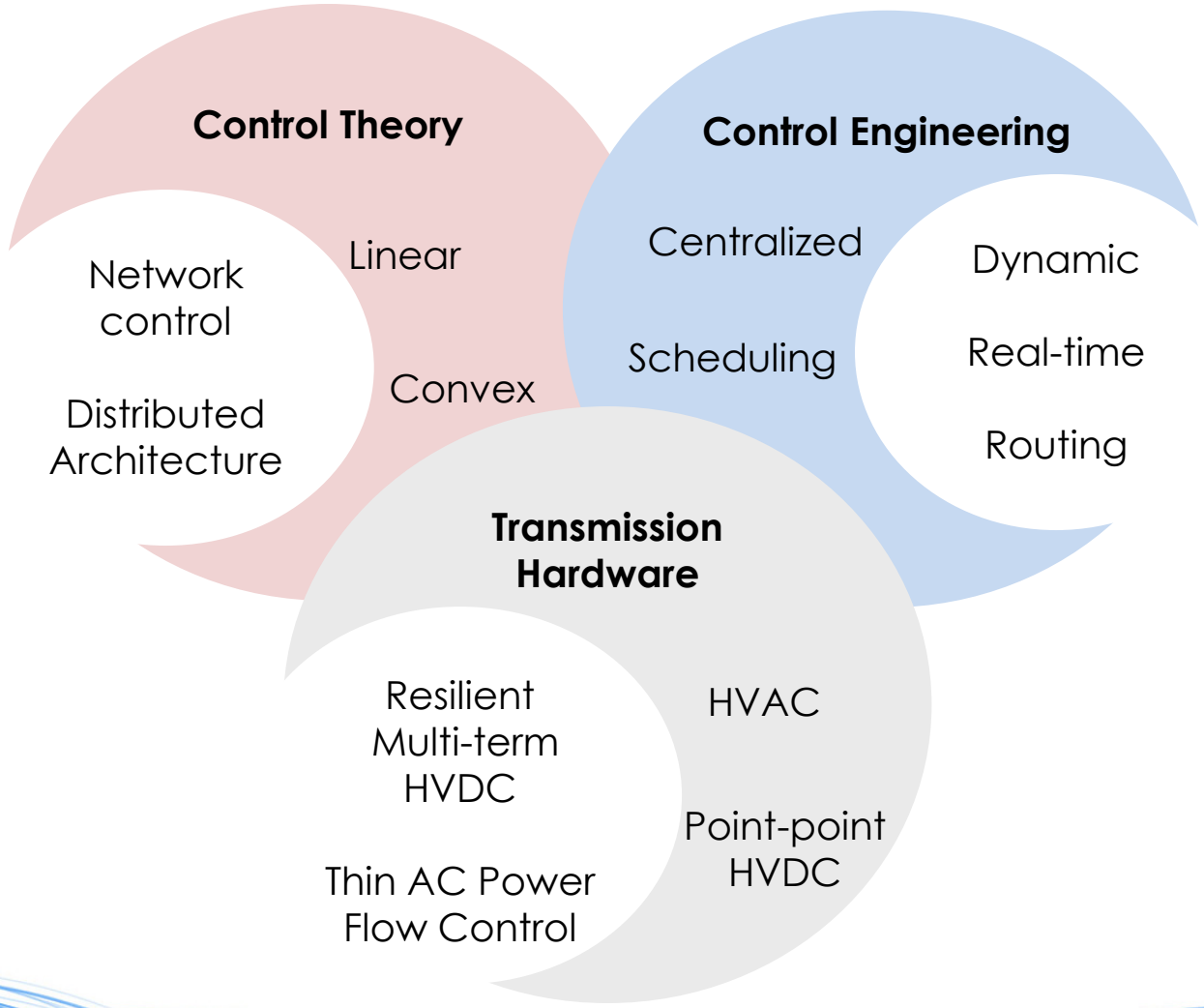
Existing infrastructure lifetimes

Black & Veatch, "2009/2010 Fourth annual strategic directions In the electric utility industry survey."

Substantial growth of non-dispatchable generation



Workshops find the white space



What makes an ARPA-E project?

1. Impact

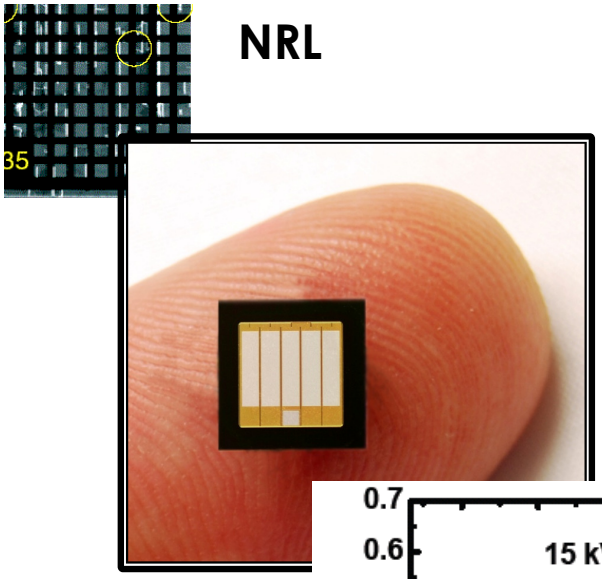
2. Transform

3. Bridge

4. Team

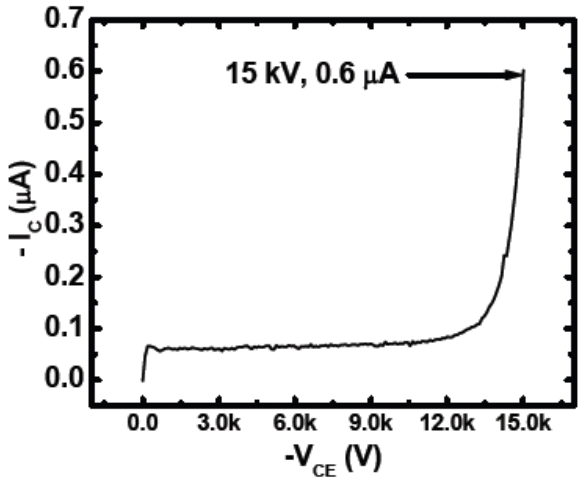
Vertically Integrated Teams

HV Grid-Scale Transistors and Solid-State Transformers



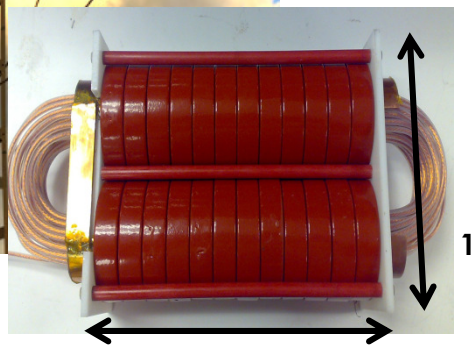
NRL

Cree



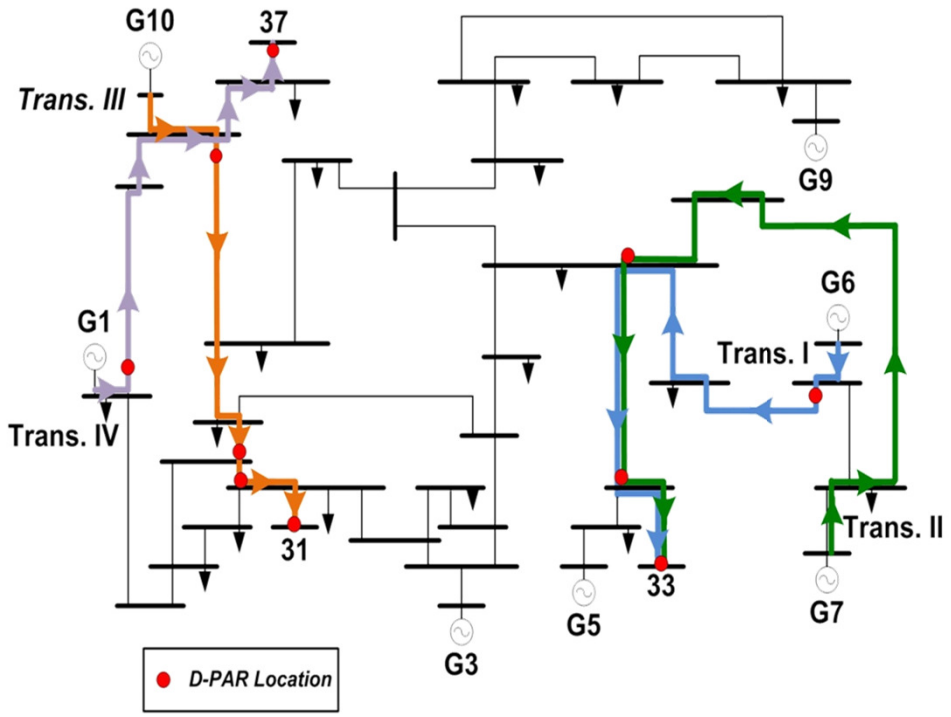
NCSU

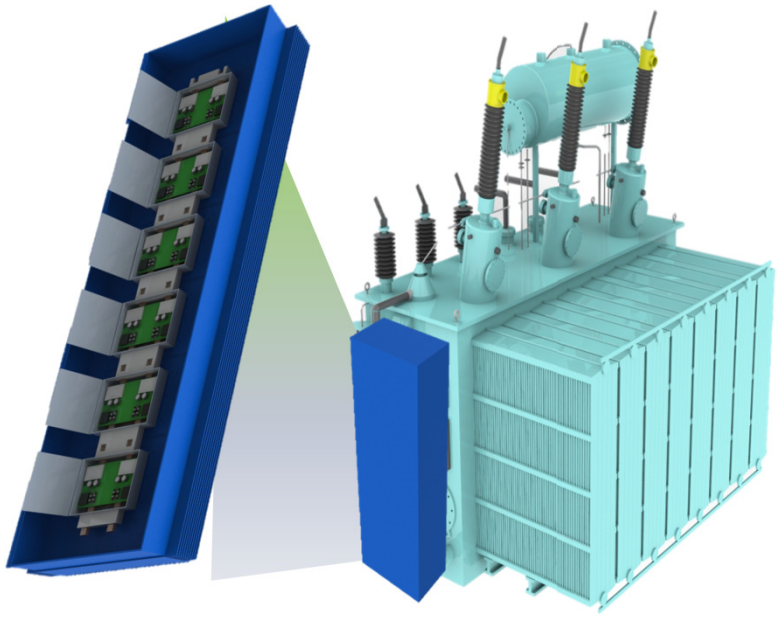
ABB



30kVA, 50kHz link transformer

Vertically Integrated Teams
Power Routers





augment existing transformers

Varentec EPRI

Georgia Tech AUKESHA TRANSFORMERS · SERVICE TRAINING · COMPONENTS

- 10X lower than BAU ($30/kW)
- 13 kV/1MW units in tie-line field demo
- 13 kV 5 bus test bed to show routing

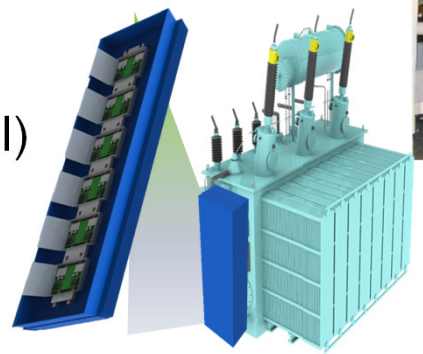
SOUTHERN COMPANY

arpa·e

ARPAE PROGRAMS DEFINE PROBLEMS…
…NOT SOLUTIONS

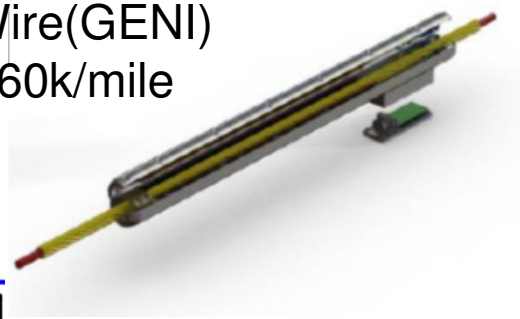
NYPA UPFC

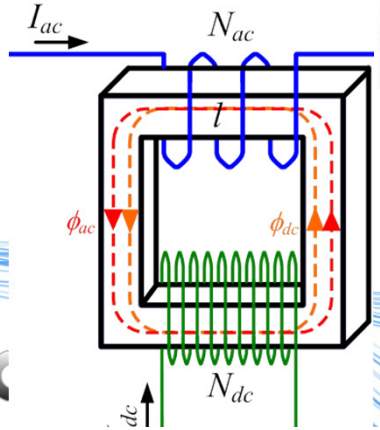
$140-300/kVA



Varentec (GENI)
$20-30/kVA

SmartWire(GENI)
$36k-60k/mile





ORNL (GENI)
$4/kVA

A PORTFOLIO OF APPROACHES

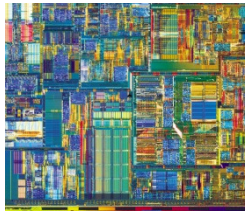
12

Vertically Integrated Teams
Algorithms for Topology Control

Charles River Associates	Project management, algorithms, impact assessments, integration, commercialization
Boston University	Optimization algorithms, market design issues
Tufts University/ Northeastern University	Express algorithms for voltage and transient stability analysis
Polaris Systems Opt./ Paragon Decision Technology	Software implementation
PJM Interconnection	Operation and implementation consulting and review

Estimates indicate that implementation of TC in the entire US electrical grid would save of $1-2 billion in generation costs and would reduce the needs for transmission investments

STIMULATING INNOVATION FROM ADJACENT FIELDS



COLUMBIA UNIVERSITY
DIGITAL KNOWLEDGE VENTURES

BERKELEY LAB

OpenADR, low-cost, internet-protocol based telemetry solutions, and intelligent forecasting and optimization techniques to provide "personalized" dynamic price signals to *millions* of customers in timeframes suitable for providing ancillary services to the grid

arpa·e

What makes an ARPA-E project?

1. Impact

- High impact on ARPA-E mission areas
- Credible path to market
- Large commercial application

2. Transform

- Challenges what is possible
- Disrupts existing learning curves
- Leaps beyond today's technologies

3. Bridge

- Translate science into breakthrough technology
- Not researched or funded elsewhere
- Catalyzes new interest and investment

4. Team

- Best-in-class people
- Cross-disciplinary skill sets
- Translation oriented